

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (Previously Presented): A method of determining a time of flight of a signal transmitted between a transmitter and a receiver, said method comprising the steps of:

at a signal transducer of the transmitter, generating a first ultrasonic signal comprising a plurality of cycles of a characteristic waveform feature;

at the signal transducer of the transmitter, generating a second ultrasonic signal comprising a plurality of cycles of the characteristic waveform feature and further comprising a waveform modification being a phase shift in the cycle of a characteristic waveform feature introduced at a predetermined point in time of a duration of the second ultrasonic signal;

receiving said first and second generated signals at the receiver;

determining a time of reception of the introduced phase shift in the second ultrasonic signal by comparing the waveform of the first received signal to the waveform of the second ultrasonic signals and determining a point of diversion between corresponding characteristic waveform features of the first and second received signals ;

determining a time of flight of the second ultrasonic signal based on the determined time of reception of the introduced phase shift and its time of generation.

2. (Previously Presented): The method of claim 1 wherein the step of determining a point of diversion further comprises:

calculating a difference between a value of the first received signal and a corresponding value of the second received signal at each point of occurrence of a characteristic waveform feature within the first received signal;

designating the point of diversion as the first point of occurrence at which the calculated difference is greater than the value of the second received signal.

3. (Previously Presented): The method of claim 2 further comprising the step of:
calculating the difference between the time of the point of diversion and the time
of generation of the introduced phase shift.
4. (Previously Presented): The method of claim 2 further comprising the steps
of:
measuring a time relationship between the introduced phase shift and the point of
diversion and;
calculating the difference between the time of reception, based on the measured
time relationship, and the time of generation of the introduced phase shift.
5. (cancelled).
6. (Previously Presented): The method of claim 1 further comprising the step
of:
repeating the steps of generating and receiving such that successive first and
second ultrasonic signals are super positioned at the step of determining.
7. (Previously Presented): The method of claim 1, wherein the characteristic
waveform feature of a signal is one of:
 - a) a peak;
 - b) a combination of peaks;
 - c) a zero-crossing;
 - d) a combination of zero-crossings.
8. (Previously Presented): The method of claim 1, wherein the phase shift is
introduced near the start of the second ultrasonic signal.

9. (Previously Presented): The method of claim 8 wherein the phase shift is introduced at one of a third, fourth or fifth waveform peak after the start of the second ultrasonic signal.

10. (Previously Presented): The method of claim 1, wherein the phase shift comprises a phase inversion.

11. (Cancelled).

12. (Previously Presented): The method of claim 1, wherein the signal transducers of the transmitter is driven at a resonant frequency in a frequency range of about 60 kHz to about 90 kHz.

13. (Currently Amended): Apparatus adapted to determine the time of flight of a signal transmitted between a transmitter and a receiver, said apparatus comprising:

processor means adapted to operate in accordance with a predetermined instruction set,

said apparatus, in conjunction with said instruction set, being adapted to perform ~~the method of claim 1~~ cause a transducer of a transmitter to transmit, to a receiver, a first ultrasonic signal comprising a plurality of cycles of a characteristic waveform feature; and to transmit, to the receiver, a second ultrasonic signal comprising a plurality of cycles of the characteristic waveform feature and further comprising a waveform modification being a phase shift in the cycle of a characteristic waveform feature said waveform modification being introduced at a predetermined point in time of a duration of the second ultrasonic signal;

the processor means being further adapted to:

determine a time of reception of the introduced phase shift in the second ultrasonic signal at the receiver by comparing the waveform of a first received signal to the waveform of a second received signal and determining a point of diversion between

corresponding characteristic waveform features of the first and second received signals;
and

determine a time of flight of the second ultrasonic signal based on the determined
time of reception of the introduced phase shift and its time of generation.

14. (Currently Amended): A method of determining a time of flight of a signal transmitted between a transmitter and a receiver, said method comprising the steps of:

generating at a transducer ~~or~~ of the transmitter a first and a second ultrasonic signal, where both signals comprise plurality of cycles of a characteristic waveform feature, and the second ultrasonic signal further comprises a waveform modification introduced at a predetermined point in time of the duration of the second ultrasonic signal, and said waveform modification comprises a phase shift in a cycle of the characteristic waveform feature;

receiving said first and second generated signals at the receiver;

scanning through said the first received signal and the second received signal in time to determine a point of diversion between the characteristic waveform features of the first received signal and the corresponding characteristic waveform feature of the second received signal, wherein said point of diversion corresponds to a time of reception of the introduced waveform modification at the receiver;

determining the time of flight of the second ultrasonic signal on the basis of the time of reception of the introduced waveform and its time of introduction into the second ultrasonic signal.

15. (Previously Presented): The method of claim 14 further comprising the steps of:

for each characteristic waveform feature received in the first received signal, calculating a difference between a value of the first received signal and a temporally corresponding value of the second received signal;

designating the first point at which the calculated difference is greater than the value of the second received signal as a point of diversion.

16. (Previously Presented): The method of claim 15 further comprising the step of:

calculating the difference between the time of the point of diversion and the time of generation of the introduced phase shift.

17. (Previously Presented): The method of claim 15 further comprising the step of:

measuring a time relationship between an introduced phase shift and the point of diversion and calculating the difference between the time of reception, based on the measured time relationship, and the time of generation of the introduced phase shift.

18-19. (cancelled).

20. (Currently Amended): Apparatus adapted to determine the time of flight of a signal transmitted between a transmitter and a receiver, said apparatus comprising:

processor means adapted to operate in accordance with a predetermined instruction set, said apparatus, in conjunction with said instruction set, being adapted to ~~perform the method of claim 14:~~

cause the transducer of the transmitter to generate a first and a second ultrasonic signal, where both signals comprise a plurality of cycles of a characteristic waveform feature, and the second ultrasonic signal further comprises a waveform modification introduced at a predetermined point in time of the duration of the second ultrasonic signal, said waveform modification comprising a phase shift in a cycle of the characteristic waveform feature;

receive said first and second signals from the receiver;

scan through said the first received signal and the second received signal in time to determine a point of diversion between the characteristic waveform features of the first received signal and the corresponding characteristic waveform feature of the and second

received signals, wherein said point of diversion corresponds to a time of reception of the introduced waveform modification at the receiver;

determine the time of flight of the second ultrasonic signal on the basis of the time of reception of the introduced waveform modification and its time of introduction into the second ultrasonic signal.

21. (Previously Presented): The method of claim 1 further comprising the steps of:

selecting a characteristic waveform feature of the first ultrasonic signal in accordance with predetermined selection criteria based on the point of diversion;

generating and receiving a plurality of first ultrasonic signals;

detecting zero-crossings of the received plurality of first ultrasonic signals which indicate the presence of the selected characteristic waveform feature in each of the received plurality of first ultrasonic signals;

estimating a position of the selected characteristic waveform feature of the received plurality of first ultrasonic signals in accordance with predetermined estimation criteria based on the detected zero crossings to provide a position estimation value;

processing the position estimation value to determine a corresponding estimation time;

calculating the time of arrival of the selected characteristic waveform feature of at least one of the received plurality of first ultrasonic signals by adding a predetermined delay time to the estimation time.

22. (Original): The method of claim 21 wherein the predetermined selection criteria comprise one of:

a) adding a predefined delay to the time of the point of diversion;

b) subtracting a predefined delay from the time of the point of diversion.

23. (Previously Presented): The method of claim 21 wherein the predetermined estimation criteria comprise:

- a) measuring the time of zero-crossings adjacent the selected characteristic waveform feature and;
- b) averaging the measured time of zero-crossings.

24. (Currently Amended): ~~The apparatus of claim 13, Apparatus adapted to determine the time of flight of a signal transmitted between a transmitter and a receiver, said apparatus comprising:~~

~~processor means adapted to operate in accordance with a predetermined instruction set, said apparatus, in conjunction with said instruction set, being adapted to perform the method of claim 21 wherein said apparatus comprises:~~

~~a signal transducer generating and receiving wherein the transducer of the transmitter is controlled to generate a plurality of first ultrasonic signals, said plurality of first ultrasonic signals being received at the receiver;~~

~~said apparatus further comprising:~~

~~waveform feature selection means operatively connected to the signal transducer receiver and the processor means for selecting a characteristic waveform feature of the first ultrasonic signal in accordance with predetermined selection criteria based on the point of diversion;~~

~~zero-crossing detection means operatively connected to the transducer receiver and the processor means for detecting zero-crossings of the received plurality of first ultrasonic signals which indicate the presence of the selected characteristic waveform feature in each of the received plurality of first ultrasonic signals;~~

~~signal position estimation means operatively connected to the zero-crossing detection means and the processor means for estimating a position of the selected characteristic waveform feature of the plurality of received first ultrasonic signals in accordance with predetermined estimation criteria based on the detected zero-crossings to provide a position estimation value;~~

~~wherein the processor means is further configured to~~

~~processes the position estimation value to determine a corresponding estimation time; and~~

calculates the time of arrival of the selected characteristic waveform feature of at least one of the plurality of received first ultrasonic signals by adding a predetermined delay time to the estimation time.

25. (Original): The apparatus of claim 24 wherein said signal position estimation means comprises a dual slope integrator.

26. (Previously Presented): The apparatus of claim 24 wherein said plurality of received first ultrasonic signals are digitised and said processor means comprises digital data processing means comprising said zero-crossing detection means and said signal position estimation means.

27. (Currently Amended): A method of monitoring flow through a particle detector of an aspirated smoke detector system, the aspirated smoke detector comprising a flow path along which air is drawn, and a flow sensor including a first transducer and a second transducer arranged to detect flow in the flow path, the method comprising the steps of:

measuring a ~~transit~~ time of flight (t_1) of a forward signal, transmitted from the first transducer in a forward direction, being generally in the direction of flow along the flow path, to the second transducer, the ~~transit~~ time of flight (t_1) being measured using a method as claimed in claim 1;

measuring a second ~~transit~~ time of flight (t_2) of a return signal, transmitted from the second transducer in a return direction, being generally opposite the direction of flow along the flow path, to the first transducer, the ~~transit~~ time of flight (t_2) being measured using a method as claimed in claim 1;

determining a volumetric flow rate, f , in the flow path using the general flow calculation:

$$f = S \times A$$

where

A = cross sectional area of an air flow path through the detector system;

s = speed of air through the detector system such that s is given by;

$$s = \frac{d}{2} \left(\frac{1}{t_2} - \frac{1}{t_1} \right)$$

and d is a distance travelled by the signal between the first and second transducer;
and wherein both t_1 and t_2 are determined in accordance with the method of claim

1.

28. (Currently Amended): Apparatus adapted to monitor air flow through a flow path of a particle detector of an aspirated smoke detector system, said apparatus comprising:

first and second transducers arranged to transmit ultrasonic signals through the air flow in the flow path,

processor means adapted to operate in accordance with a predetermined instruction set, said apparatus, in conjunction with said instruction set, being adapted to: ~~perform the method of claim 27~~

transmit, from the first transducer to the second transducer and in a forward direction, being generally in a direction of flow along the flow path, a first ultrasonic signal comprising a plurality of cycles of a first characteristic waveform feature;

transmit, from the first transducer to the second transducer and in said forward direction, a second ultrasonic signal comprising a plurality of cycles of the first characteristic waveform feature and further comprising a waveform modification being a first phase shift in a cycle of the first characteristic waveform feature that is introduced at a predetermined point in time of a duration of the second ultrasonic signal;

transmit, from the second transducer to the first transducer and in a return direction, being generally opposite the direction of flow along the flow path, a third ultrasonic signal comprising a plurality of cycles of a second characteristic waveform feature; and

transmit, from the second transducer to the first transducer and in said return direction, a fourth ultrasonic signal comprising a plurality of cycles of the

second characteristic waveform feature and further comprising a second waveform modification being a second phase shift in a cycle of the second characteristic waveform feature that is introduced at a predetermined point in time of a duration of the fourth ultrasonic signal; and
the processor means being configured to:

determine a time of reception of the introduced first phase shift in the second ultrasonic signal at the second transducer, by comparing the waveform of the first received ultrasonic signal to the waveform of the second received ultrasonic signal and determining a point of diversion between corresponding first characteristic waveform features of the first and second received signals;

determine a time of flight (t_1) of the second ultrasonic signal based on the determined time of reception of the introduced first phase shift and its time of generation;

determine a time of reception of the introduced second phase shift in the fourth ultrasonic signal at the first transducer by comparing the waveform of the third received ultrasonic signal to the waveform of the fourth received ultrasonic signal and determining a point of diversion between corresponding second characteristic waveform features of the third and fourth received signals;

determine a time of flight (t_2) of the fourth ultrasonic signal based on the determined time of reception of the second introduced phase shift and its time of generation; and

determine a volumetric flow rate, f , in the flow path using the general flow calculation:

$$f = S \times A$$

where,

A = cross sectional area of the air flow path;

s = speed of air in the flow path given by;

$$s = \frac{d}{2} \left(\frac{1}{t_2} - \frac{1}{t_1} \right)$$

where d is a distance travelled by the first, second, third and fourth ultrasonic signals transmitted between the first and second transducers.

29. (Currently Amended): A method of detecting one or more blocked sampling holes in a pipe of an aspirated smoke detector system, said aspirated smoke detector system comprising a sampling network including one or more sampling holes, and aspirator for drawing air through the sampling network to the detector; and a flow sensor arranged to detect air flow in an airflow path of the aspirated smoke detector system; said method comprising:

~~ascertaining the base flow of fluid through a particle detector using a flow sensor of said aspirated smoke detector system according to the method of claim 27 by~~
measuring a time of flight (t_1) of a forward signal, transmitted from the first transducer in a forward direction, being generally in the direction of flow along the flow path, to the second transducer, the time of flight (t_1) being measured using a method as claimed in claim 1;

measuring a second time of flight (t_2) of a return signal, transmitted from the second transducer in a return direction, being generally opposite the direction of flow along the flow path, to the first transducer, the time of flight (t_2) being measured using a method as claimed in claim 1;

determining a volumetric flow rate, f, in the flow path using the general flow calculation:

$$f = S \times A$$

A = cross sectional area of an air flow path through the detector system;

s = speed of air through the detector system such that s is given by;

$$s = \frac{d}{2} \left(\frac{1}{t_2} - \frac{1}{t_1} \right)$$

and d is a distance travelled by the signals between the first and second transducer using;

~~monitoring subsequent flow through the particle detector using the flow sensor according to the method of claim 27 by~~
measuring a time of flight (t_1) of a forward signal,

transmitted from the first transducer in a forward direction, being generally in the direction of flow along the flow path, to the second transducer, the time of flight (t_1) being measured using a method as claimed in claim 1;

measuring a second time of flight (t_2) of a return signal, transmitted from the second transducer in a return direction, being generally opposite the direction of flow along the flow path, to the first transducer, the time of flight (t_2) being measured using a method as claimed in claim 1;

determining a volumetric flow rate, f , in the flow path using the general flow calculation:

$$f = S \times A$$

A = cross sectional area of an air flow path through the detector system;

s = speed of air through the detector system such that s is given by;

$$s = \frac{d}{2} \left(\frac{1}{t_2} - \frac{1}{t_1} \right)$$

and d is a distance travelled by the signals between the first and second transducer.

comparing the subsequent flow with the base flow, and determining that one or more sampling holes of the sampling network are blocked and indicating a fault, if the difference between the base flow and the subsequent flow exceeds a predetermined threshold.

30-31. (Cancelled).

32. (Previously Presented): The method of claim 29, wherein the difference between base flow and subsequent flow is compared over a length of time.

33. (cancelled).

34. (Currently Amended): An aspirated smoke detector comprising:
- a particle detector,
 - a sampling network including one or more sampling points; and
 - an aspirator for drawing air through the sampling network, through ~~to~~ the detector detector along a flow path;
 - ~~an inlet,~~
 - ~~an outlet;~~ and
 - an ultrasonic flow sensor in fluid communication with the particle detector and
 - including first and second transducers arranged to ~~detect the~~ monitor a flow rate of air in the flow path, entering the particle detector according to the method of claim 27, wherein the ultrasonic flow sensor is configured to:
- transmit, from the first transducer to the second transducer and in a forward direction, being generally in a direction of flow along the flow path, a first ultrasonic signal comprising a plurality of cycles of a first characteristic waveform feature;
 - transmit, from the first transducer to the second transducer and in said forward direction, a second ultrasonic signal comprising a plurality of cycles of the first characteristic waveform feature and further comprising a waveform modification being a first phase shift in a cycle of the first characteristic waveform feature that is introduced at a predetermined point in time of a duration of the second ultrasonic signal;
 - transmit, from the second transducer to the first transducer and in a return direction, being generally opposite the direction of flow along the flow path, a third ultrasonic signal comprising a plurality of cycles of a second characteristic waveform feature; and
 - transmit, from the second transducer to the first transducer and in said return direction, a fourth ultrasonic signal comprising a plurality of cycles of the second characteristic waveform feature and further comprising a second waveform modification being a second phase shift in a cycle of the second characteristic waveform feature that is introduced at a predetermined point in time of a duration of the fourth ultrasonic signal; and

a processing system configured to:

determine a time of reception of the introduced first phase shift in the second ultrasonic signal at the second transducer, by comparing the waveform of the first received ultrasonic signal to the waveform of the second received ultrasonic signal and determining a point of diversion between corresponding first characteristic waveform features of the first and second received signals;

determine a time of flight (t_1) of the second ultrasonic signal based on the determined time of reception of the introduced first phase shift and its time of generation;

determine a time of reception of the introduced second phase shift in the fourth ultrasonic signal at the first transducer by comparing the waveform of the third received ultrasonic signal to the waveform of the fourth received ultrasonic signal and determining a point of diversion between corresponding second characteristic waveform features of the third and fourth received signals;

determine a time of flight (t_2) of the fourth ultrasonic signal based on the determined time of reception of the second introduced phase shift and its time of generation; and

determine a volumetric flow rate, f , in the flow path using the general flow calculation:

$$f = S \times A$$

where,

A = cross sectional area of the air flow path;

s = speed of air in the flow path given by;

$$s = \frac{d}{2} \left(\frac{1}{t_2} - \frac{1}{t_1} \right)$$

where d is a distance travelled by the first, second, third and fourth ultrasonic signals transmitted between the first and second transducers.

35. (Currently Amended): The detector of claim 34 wherein the ultrasonic flow sensor is in fluid communication with the sampling network and is operationally arranged to measure the partial flow of fluid through ~~a~~ the sampling network.

36. (Previously Presented): The smoke detector of claim 34, wherein the particle detector detects particles in a portion of the air flow flowing through the sampling network.

37. (Currently Amended): The smoke detector of claim 34 wherein the ultrasonic flow sensor is located in the sampling network.

38. (Currently Amended): The smoke detector of claim 34, wherein the ultrasonic flow sensor is located in a housing ~~for~~ of the particle detector.

39. (Currently Amended): The smoke detector of claim 34, having a branch in ~~the~~ inlet flow path allowing air to bypass the particle detector.

40. (Cancelled).

41. (Currently Amended) A non-transitory computer readable recording medium having embodied thereon a computer program for executing a method of determining a time of flight of a signal transmitted between a transmitter and a receiver, said method comprising the steps of: the method according to claim 1

at a signal transducer of the transmitter, generating a first ultrasonic signal comprising a plurality of cycles of a characteristic waveform feature;

at the signal transducer of the transmitter, generating a second ultrasonic signal comprising a plurality of cycles of the characteristic waveform feature and further comprising a waveform modification being a phase shift in the cycle of a characteristic waveform feature introduced at a predetermined point in time of a duration of the second ultrasonic signal;

receiving said first and second generated signals at the receiver;
determining a time of reception of the introduced phase shift in the second
ultrasonic signal by comparing the waveform of the first received signal to the waveform
of the second ultrasonic signals and determining a point of diversion between
corresponding characteristic waveform features of the first and second received signals ;
determining a time of flight of the second ultrasonic signal based on the determined time
of reception of the introduced phase shift and its time of generation..

42. (Currently Amended): A non-transitory computer readable ~~recording~~ medium having embodied thereon a computer program for executing a method of monitoring flow through a particle detector of an aspirated smoke detector system, the aspirated smoke detector comprising a flow path along which air is drawn, and a flow sensor including a first transducer and a second transducer arranged to detect flow in the flow path, the method comprising the steps of:

measuring a time of flight (t_1) of a forward signal, transmitted from the first
transducer in a forward direction, being generally in the direction of flow along the flow
path, to the second transducer, the time of flight (t_1) being measured using a method as
claimed in claim 1;

measuring a second time of flight (t_2) of a return signal, transmitted from the second
transducer in a return direction, being generally opposite the direction of flow along the flow
path, to the first transducer, the time of flight (t_2) being measured using a method as claimed
in claim 1;

determining a volumetric flow rate, f , in the flow path using the general flow
calculation:

$$f = S \times A$$

where

A = cross sectional area of an air flow path through the detector system;

s = speed of air through the detector system such that s is given by:

$$s = \frac{d}{2} \left(\frac{1}{t_2} - \frac{1}{t_1} \right)$$

and d is a distance travelled by the signal between the first and second transducer;
and wherein both t_1 and t_2 are determined in accordance with the method of claim 1,
the method according to claim 27.

43. (Currently Amended): A non-transitory computer readable ~~recording~~ medium having embodied thereon a computer program for executing a method of detecting one or more blocked sampling holes in a pipe of an aspirated smoke detector system, said aspirated smoke detector system comprising a sampling network including one or more sampling holes, and aspirator for drawing air through the sampling network to the detector; and a flow sensor arranged to detect air flow in an airflow path of the aspirated smoke detector system; said method comprising:

ascertaining the base flow of fluid through a particle detector by measuring a time of flight (t_1) of a forward signal, transmitted from the first transducer in a forward direction, being generally in the direction of flow along the flow path, to the second transducer, the time of flight (t_1) being measured using a method as claimed in claim 1;
measuring a second time of flight (t_2) of a return signal, transmitted from the second transducer in a return direction, being generally opposite the direction of flow along the flow path, to the first transducer, the time of flight (t_2) being measured using a method as claimed in claim 1;

determining a volumetric flow rate, f, in the flow path using the general flow calculation:

$$f = S \times A$$

A = cross sectional area of an air flow path through the detector system;

s = speed of air through the detector system such that s is given by:

$$s = \frac{d}{2} \left(\frac{1}{t_2} - \frac{1}{t_1} \right)$$

and d is a distance travelled by the signals between the first and second transducer using;

monitoring subsequent flow through the particle detector by measuring a time of flight (t_1) of a forward signal, transmitted from the first transducer in a forward direction, being generally in the direction of flow along the flow path, to the second transducer, the time of flight (t_1) being measured using a method as claimed in claim 1;

measuring a second time of flight (t_2) of a return signal, transmitted from the second transducer in a return direction, being generally opposite the direction of flow along the flow path, to the first transducer, the time of flight (t_2) being measured using a method as claimed in claim 1;

determining a volumetric flow rate, f , in the flow path using the general flow calculation:

$$f = S \times A$$

A = cross sectional area of an air flow path through the detector system;

s = speed of air through the detector system such that s is given by;

$$s = \frac{d}{2} \left(\frac{1}{t_2} - \frac{1}{t_1} \right)$$

and d is a distance travelled by the signals between the first and second transducer.

comparing the subsequent flow with the base flow, and determining that one or more sampling holes of the sampling network are blocked and indicating a fault, if the difference between the base flow and the subsequent flow exceeds a predetermined threshold.~~the method according to claim 29.~~

44- 46. (Cancelled).

47. (Currently Amended): A method of monitoring flow through a particle detector of an aspirated smoke detector system, the aspirated smoke detector system including a flow path

along which air is drawn, and a flow sensor including a first and second transducers arranged to detect flow in the flow path, the method comprising the steps of:

ascertaining the base flow of fluid through a particle detector ~~using a flow sensor,~~
~~using a method as claimed in claim 27~~ by measuring a time of flight (t_1) of a forward
signal, transmitted from the first transducer in a forward direction, being generally in the
direction of flow along the flow path, to the second transducer, the time of flight (t_1)
being measured using a method as claimed in claim 1;

measuring a second time of flight (t_2) of a return signal, transmitted from the
second transducer in a return direction, being generally opposite the direction of flow
along the flow path, to the first transducer, the time of flight (t_2) being measured using a
method as claimed in claim 1;

determining a volumetric flow rate, f , in the flow path using the general flow
calculation:

$$f = S \times A$$

A = cross sectional area of an air flow path through the detector system;

s = speed of air through the detector system such that s is given by;

$$s = \frac{d}{2} \left(\frac{1}{t_2} - \frac{1}{t_1} \right)$$

and d is a distance travelled by the signals between the first and second
transducer;

monitoring subsequent flow through the particle detector measuring a time of
flight (t_1) of a forward signal, transmitted from the first transducer in a forward direction,
being generally in the direction of flow along the flow path, to the second transducer, the
time of flight (t_1) being measured using a method as claimed in claim 1;

measuring a second time of flight (t_2) of a return signal, transmitted from the
second transducer in a return direction, being generally opposite the direction of flow
along the flow path, to the first transducer, the time of flight (t_2) being measured using a
method as claimed in claim 1;

determining a volumetric flow rate, f, in the flow path using the general flow calculation:

$$f = S \times A$$

A = cross sectional area of an air flow path through the detector system;

s = speed of air through the detector system such that s is given by;

$$s = \frac{d}{2} \left(\frac{1}{t_2} - \frac{1}{t_1} \right)$$

and d is a distance travelled by the signals between the first and second transducer;

~~monitoring subsequent flow through the particle detector using a method as claimed in claim 27;~~

comparing the subsequent flow with the base flow, and indicating a fault if the difference between the base flow and the subsequent flow exceeds a predetermined threshold.